Development of data acquisition and analysis infrastructure for high-speed X-ray imaging detector CITIUS

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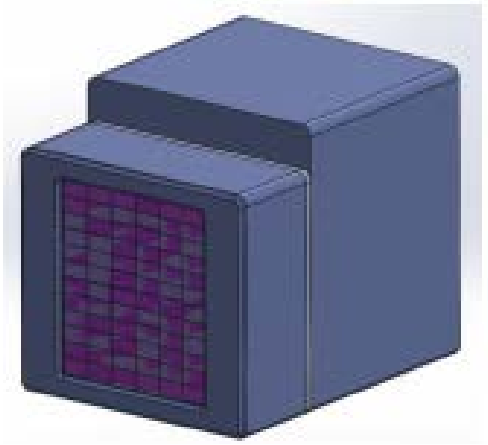
CITIUS: Solution to demands on X-ray imaging detectors

Performance of 20M-pixel CITIUS[1]

Parameters	Value
Pixel size	72.6 µm
Pixel count	20.2 Mpixels
Frame rate	**17.4 kfps**
Max. count rate @12 keV	**600 Mcps/pixel** (= 114 Gcps/mm^2)
Year in operation	2023 (expected)



Meets demands from anticipated experiments at SPring-8-II[2]:

- frame rate over 10 kfps,
- high pixel count,
- count rate over 500 Mcps/pixel.

But,

Requires a CAREFUL design of the data handling scheme to the peak stream rate* of 1.4 TB/s:

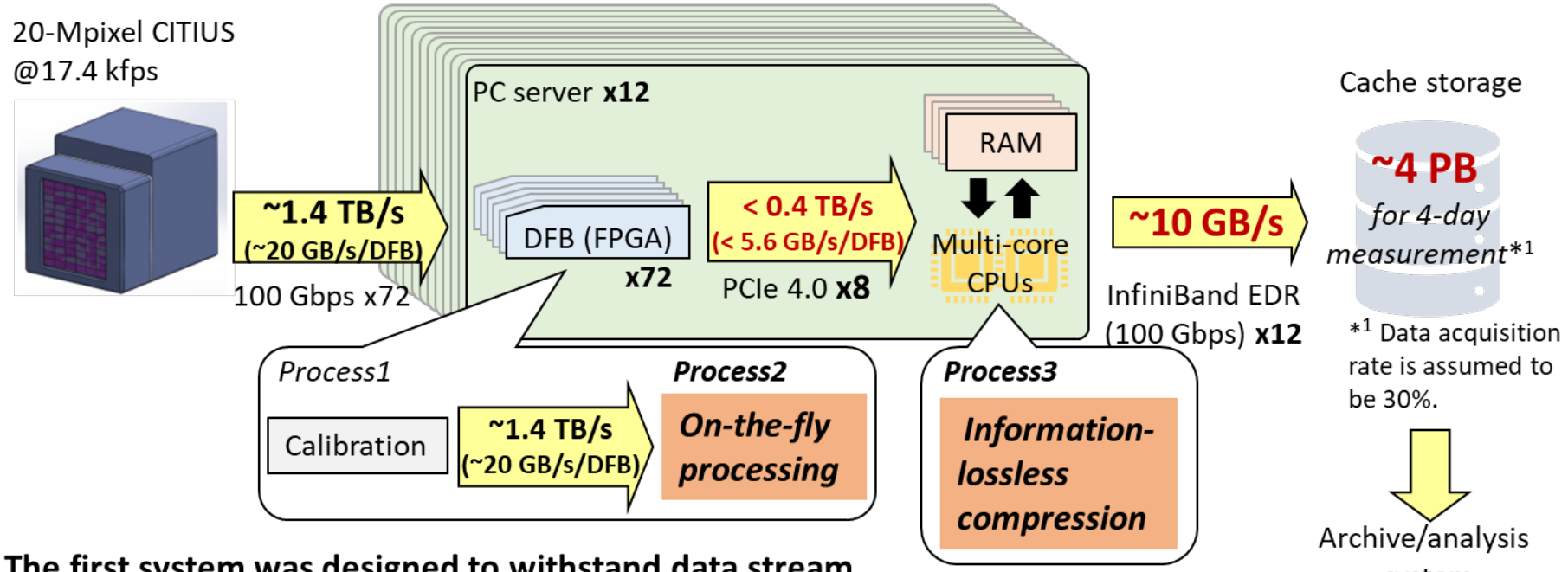
- data transfer,
- on-the-fly processing,
- storage,
- post-analysis.

*Stream rate is information data rate.

[1] T. Hatsui, Presentation at the 2nd R-CCS International Symposium (Feb. 2020)
[2] SPring-8-II Conceptual Design Report (2014), and updated values

*Baseline implementation for reduction of a **1.4-TB/s** stream rate*

Baseline implementation



The first system was designed to withstand data stream with an overall reduction by x140.

Components under development:

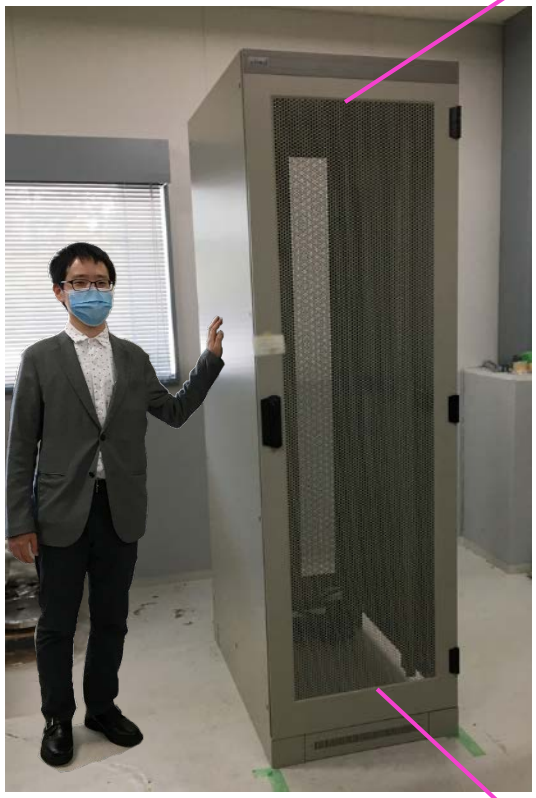
- **On-the-fly calibration** (on Data-Faming Board (DFB))
- **On-the-fly processing** (on DFB): data accumulation, selection, veto mechanism, etc.
- **Information-lossless compression by x3~x1000** (on CPU)

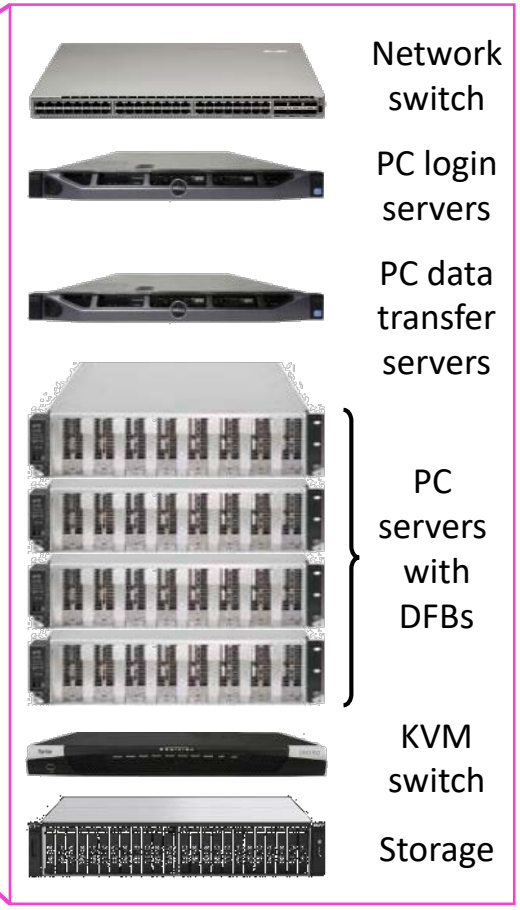
Toward operation of 20M-pixel CITIUS detector

Milestones:

1. **840-kpixel CITIUS from 07/2021.**
2. **2.2-Mpixel CITIUS from 10/2021.**
3. **20-Mpixel CITIUS from 2023.**

The data acquisition and analysis system for the 1st milestone has been designed and is under assembly.





Summary, Acknowledgements

Summary

- Operation of a 20-Mpixel CITIUS at 17.4 kfps has **a peak stream rate of 1.4 TB/s**, which requires a careful design of the data handling scheme.
- Our first baseline implementation includes **on-the-fly processing** and **information-lossless compression** in order to withstand data stream with an overall reduction by x140.
- Our 1st milestone to providing a 20-Mpixel CITIUS is to operate an 840-kpixel CITIUS in 07/2021. The data handling system has been designed.

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